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DEVELOPMENT OF A REVISED COMPOSITE FOR NROTC SELECTION

MANPOWER AND PERSONNEL LABORATORY

DEPARTMENT OF THE NAVY
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From: Commanding Officer, Navy Personnel Research and Development Center

Subj: **DEVELOPMENT OF A REVISED COMPOSITE FOR NROTC SELECTION**

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1. Enclosure (1) describes the development of the revised selector composite for the 4-year NROTC scholarship program that was implemented in 1985. The selector composite uses tests and questionnaires that have been given to NROTC applicants over the past several years but re-weights those instruments to achieve better prediction of NROTC performance. The composite predicts grade point average, naval aptitude, and naval science grades much better than the formerly used Overall Index or a composite patterned after that used by the Naval Academy. Tables for interpreting applicant scores on the composite are provided.

2. The work reported in enclosure (1) is the first stage of an effort to improve the NROTC selection system. It was conducted within work unit WRB2714 (NROTC Scholarship Procedures) and sponsored by the Chief of Naval Operations (OP-01).

3. This report is being distributed to document work of interest to Navy offices and researchers concerned with similar operational and methodological issues.

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DEVELOPMENT OF A REVISED COMPOSITE FOR NROTC SELECTION

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To update the NROTC selection system, 20 experimental selector composites were evaluated for their ability to predict performance in the NROTC program. The composites used up to six predictors measuring academic ability, vocational interests, background, and performance during a personal interview. Criteria were grade point average, naval aptitude, and naval science grades. Cross-validities of the 20 composites were compared with validities of the existing operational selector and a selector patterned after the Naval Academy's equation. All experimental composites predicted NROTC performance better than the present composite, and most were also better than a composite using the Naval Academy's weights for the indicators of academic ability and high school academic performance. Personal interviews, vocational interests, and background information added little to the predictions, although these measures may be useful in assessing other criteria if rescaled. Based on these results, one experimental composite was implemented by the Navy Recruiting Command. Additional research to improve the NROTC selection system should be pursued.

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SUMMARY

Problem

The Navy Reserve Officer Training Corps (NROTC) selector composite in use in 1984 was developed several years ago to help the Selection Board evaluate applicants. The composite had several weaknesses: (1) it did not take advantage of the most advanced statistical techniques for prediction since it was developed as a set of tables for manual use, and (2) the predictors on which it is based had not been rescaled in recent years.

Objective

This project took the first step toward updating the NROTC selection system, namely, developing an optimally weighted, computer-generated combination of the performance predictors available for NROTC applicants.

Approach

Measures for each applicant included indicators of academic ability, high school academic performance, vocational interests, background, and performance during a personal interview. Different combinations of these measures were evaluated by multiple regression to determine which ones best predict later academic and military performance in NROTC. The composites were also compared with the 1984 NROTC selector and with a composite patterned after the Naval Academy selector composite.

Results

Validities of the regression-based experimental composites were substantially greater than those of the existing NROTC selector and were almost always greater than those of the composite based on the Naval Academy's weights for predictor variables. The single most valid predictor was high school academic performance. In combination with the indicators of academic ability, it predicted the criteria almost as well as all six predictors together.

Conclusions

1. Useful predictions of NROTC performance can be achieved using indicators of academic ability and high school academic performance. These predictions are improved very little by adding personal interviews, vocational interests, and background information to the prediction equation, although these measures may be useful if rescaled and evaluated against other criteria.

2. All of the experimental composites were more valid than the existing NROTC selector composite, and most were also better than a composite using the Naval Academy's weights for the indicators of academic ability and high school academic performance.

Recommendations

1. One of the better experimental selector composites should be implemented operationally. (This has been done, starting with the February 1985 Selection Board.)

2. Research for improving NROTC selection should continue. This could include developing an ongoing database, refining and/or rescaling predictors and criteria, validating against other and longer range criteria, and developing new predictors.

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INTRODUCTION

Problem and Background

The Navy Recruiting Command (CNRC) modified the Navy Reserve Officers Training Corps (NROTC) selection system in the late 1960s to incorporate a number of tests, questionnaires, and measures validated and recommended by the Navy Personnel Research and Development Center (NAVPERSRANDCEN; see Neumann & Abrahams, 1969). The instruments included the Navy College Aptitude Test, a High School Record Rating, interviewers' ratings, career retention scales for the Strong Vocational Interest Blank, and a background questionnaire. These predictors were manually combined by entering a series of tables cross-referencing different predictor pairs, and an Overall Index of Academic and Officer Potential was computed for each applicant. This index was useful for predicting grade point average, naval aptitude, naval science grades, and career tenure.

Over time, however, there have been some changes to this selection system. The verbal and mathematics portions of the Scholastic Aptitude Test have replaced the Navy College Aptitude Test, the Strong Vocational Interest Blank scale has been revised to reflect a more recent version of that test (Neumann & Abrahams, 1979), and the tables used to determine the Overall Index have been computerized. Although the Overall Index retains some validity despite these changes, it is clearly not the optimal selector for NROTC (Neumann & Abrahams, 1979). Recognizing this deficiency and the success achieved at the Naval Academy by monitoring and continuously improving its selection system, the Chief of Naval Operations and the CNRC asked NAVPERSRANDCEN to develop a similar system and process for NROTC.[1] The first step was to optimally re-weight the present predictors against academic and military performance in NROTC. Later steps would be to establish an ongoing database, refine and rescale some of the predictors (e.g., the Strong-Campbell Interest Inventory and the background questionnaire), improve and expand the types of criteria being predicted, and investigate additional promising predictors.

Objective

The objective of this study was to use information currently gathered on NROTC applicants to develop an improved and updated selection composite. The composite would replace the computerized selection tables that have been used in the past with NROTC scholarship program applicants.

APPROACH

Overview

Predictors available from the CNRC included indicators of academic ability, high school academic performance, vocational interests, background, and evaluations made by a naval officer during a personal interview. The academic predictors would be most likely to predict academic criteria and the remaining predictors, military criteria. However, any equation considered for operational use should be able to predict all of these criteria

[1] Chief of Naval Operations letter of 27 January 1984 to Commanding Officer, Navy Personnel Research and Development Center.

to some extent or should at least not yield negative relationships with any of them. Accordingly, different combinations of the predictors were formed using multiple regression techniques on individuals entering NROTC in 1979 and 1980. The combinations were compared for their ability to predict each of the criteria in turn.

Predictors

There were six predictors:

1. Scholastic Aptitude Test Verbal Score (SATV) or its statistically determined equivalent derived from the English portion of the American College Test (ACT). The highest such score is used for individuals who took the ACT and/or SAT more than once.[2]

2. Scholastic Aptitude Test Mathematics Score (SATM) or its statistically determined equivalent from the Mathematics ACT. As with SATV, the highest such score is retained from multiple administrations.

3. High School Record (HSR) Rating. This predictor is derived from an individual's high school transcript or class standing following CNRC procedures (see Department of the Navy, Recruiting Command, 1980). The method of derivation varies depending upon the type of information provided by the high school (e.g., top 10%, 3.7 grade point average, average grade of 85). However, the ratings approximate the high school percentile ranks shown in Table 1.

4. Interview (INT). The INT score is a global rating of a candidate's "potential as a career naval officer" and is based on an interview conducted with each applicant by a Navy officer or warrant officer on recruiting duty. Five is the best and one the poorest INT score.

5. Strong-Campbell Interest Inventory (SCII) Career Tenure Score. This score is derived from an SCII scale that predicts officer retention 1 year beyond minimum obligated service (Neumann & Abrahams, 1978).

6. Background Questionnaire (BQ) Career Tenure Score. This score is derived from a background questionnaire scale developed in 1968 and designed to predict officer retention 2 years beyond minimum obligated service.

Criteria

Three indicators of performance in the NROTC program, each determined at the end of the second year, were used as criteria for constructing and validating predictor composites. These indicators were:

1. Grade Point Average (GPA) based on all courses that the individual had taken at his or her college.

2. Naval Aptitude (APT), a grade based on performance in the nonacademic, military aspects of the NROTC program (e.g., leadership and military appearance).

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[2] Theory and research (see Cowen & Abrahams, 1982) suggest that using an average SAT or ACT score would improve prediction. However, only the highest scores were available in the database used for this work.

Table 1

High School Record (HSR) Ratings and
Equivalent Percentiles

HSR	Equivalent Percentile Rank
100	99 and up
90	97 - 98
80	95 - 96
70	89 - 94
60	81 - 88
50	70 - 80
40	56 - 69
30	42 - 55
20	26 - 41
10	10 - 25
0	9 and below

3. Naval Science Grade (NSG), based on Navy-relevant academic subjects such as navigation and seamanship.

Each of these criteria was standardized separately within each college before being combined into a single variable to partially adjust for differences between colleges in grading systems.

Subjects

The sample included 2152 individuals entering NROTC in 1979 or 1980 who were still in the program at the end of 2 years. (These individuals represent approximately 60% of their entering NROTC year groups.) Table 2 shows the entering year, race, and sex composition of the sample.

Method

Twenty potential selector composites were developed using multiple regression techniques. These composites were chosen to address several issues of particular interest to CNRC, namely, what effect would using equal versus optimal weights for SATV and SATM have on a selection composite's validity, and what would be the effect of using only SATV, SATM, and HSR as predictors rather than a larger predictor set? The 20 composites designed to address these issues can be divided into four sets as follows:

Table 2

Characteristics of the Sample

Entering Year	Total	Males	Females	Minorities
1979	841	812	29	34
1980	1311	1271	40	76
Total	2152	2083	69	110

Set A: Composites derived using three predictors (SATV, SATM, and HSR), with SATV and SATM optimally weighted.

Set B: Composites derived using six predictors (SATV, SATM, HSR, INT, SCII, and BQ), with SATV and SATM optimally weighted.

Set C: Composites derived using three predictors (SATV, SATM, and HSR), with SATV and SATM equally weighted.

Set D: Composites derived using six predictors (SATV, SATM, HSR, INT, SCII, and BQ), with SATV and SATM equally weighted.

Each of these sets included five individual composites, one developed to predict each of the following individual or composite criteria: GPA, APT, NSG, GPA + APT, GPA + APT + NSG.[3] The composite criteria were included to generate composites that would have a higher probability of relating to several criteria simultaneously.

All 20 of the composites were evaluated for their ability to predict GPA, APT, and NSG; they were also compared with the Overall Index that has been used for NROTC selection for the last several years and with a composite formed using the Naval Academy's effective weights for SATV, SATM, and HSR.

Table 3 shows the means and standard deviations of the predictors and criteria, and their correlations with the criteria.

[3] Procedures outlined in Neumann and Abrahams (1976) were used to determine weights for the composite criteria based on weights from the single-criterion regression equations.

Table 3

Predictor and Criterion Means and Standard Deviations, and Correlations With the Criteria

Item	Mean	SD	Correlations With Criterion		
			GPA	APT	NSG
Predictor					
SATV	562.6	72.8	.10	.00	.10
SATM	659.9	61.6	.18	.00	.06
HSR	70.5	18.7	.29	.19	.20
INT	4.6	.6	.00	.05	.03
SCII	105.4	5.8	-.08	.06	.01
BQ	101.5	3.9	-.12	-.03	-.01
Criterion					
GPA	.036	.979		.40	.54
APT	.011	.982	.40		.40
NSG	.042	.956	.54	.40	

RESULTS AND DISCUSSION

Table 4 shows the validities of the 20 experimental selector composites, the Overall Index, and the selector composite that was based on the Naval Academy's weights. All of the composites predicted GPA better than they did either of the other two criteria. Validities against GPA were usually around .30, while validities against APT and NSG were more typically in the .15 to .20 range.

The validities of composites based on only three predictors were almost as good as the validities of composites based on all six predictors. (Compare Set A with Set B and Set C with Set D.) Composites equally weighting SATV and SATM were nearly as good as those optimally weighting the two predictors. (Compare Set A with Set C and Set B with Set D.) Except for the less valid APT-derived composites, there was very little difference in composite validities as a function of the criterion against which those composites were developed. (Compare the results for the five composites within each set.)

Table 4

Validities of NROTC and Comparison Composites

Item	Performance Variable the Composite was Developed to Predict	Criterion GPA	APT	NSG
Composite Set				
A	GPA	.310	.153	.19[illegible]
	APT	.247	.192	.17[illegible]
	NSG	.281	.167	.21[illegible]
	GPA + APT	.301	.177	.19[illegible]
	GPA + APT + NSG	.299	.176	.20[illegible]
B	GPA	.321	.149	.17[illegible]
	APT	.205	.207	.18[illegible]
	NSG	.264	.167	.215
	GPA + APT	.307	.181	.192
	GPA + APT + NSG	.304	.174	.205
C	GPA	.304	.157	.203
	APT	.250	.192	.177
	NSG	.303	.167	.204
	GPA + APT	.295	.180	.202
	GPA + APT + NSG	.299	.176	.203
D	GPA	.315	.147	.189
	APT	.256	.204	.194
	NSG	.284	.170	.209
	GPA + APT	.291	.193	.194
	GPA + APT + NSG	.285	.196	.197
Comparison Composites				
Overall Index		.154	.120	.153
USNA selector composite[a]		.231	.043	.130

[a]Based on weights used for Naval Academy selection.

All but one of the experimental composites were more valid than either the Overall Index or the Naval-Academy-based selector composite. The greater validity of the experimental composites is probably related to the greater weight they assign to HSR--the single most valid predictor for NROTC--as shown in Table 5. By contrast, the Naval-Academy-based composite weights SAT scores more heavily, since SATM is the most valid predictor of performance in the Academy's more technical curriculum. (I. Neumann, personal communication, March 1986.) The difference in curricula between the two programs is probably one of the principal reasons for differences in the respective optimal composites. It is interesting, however, that the predictor weights can vary substantially within certain ranges without altering validity. For example, the Set A composite with weights of 5, 30, and 65 for SATV, SATM, and HSR has almost the same validity for NROTC as the Set A composite with weights of -1, 15, and 84.

Table 5

Effective Weights of Predictors in Different Selector Composites

Item	Performance Variable the Composite was Developed to Predict	Predictor						
		SATV	SATM	SATV plus SATM	HSR	INT	SCII	BQ
Composite Set								
A	GPA	5	30		65			
	APT	-9	-15		76			
	NSG	27	-4		69			
	GPA + APT	-1	15		84			
	GPA + APT + NSG	9	9		83			
B	GPA	2	23		51	1	-8	-15
	APT	-3	-10		52	12	18	-5
	NSG	23	-3		52	9	10	4
	GPA + APT	0	10		65	8	4	-13
	GPA + APT + NSG	8	6		64	8	6	-8
C	GPA			30	70			
	APT			-21	79			
	NSG			23	77			
	GPA + APT			11	89			
	GPA + APT + NSG			15	85			
D	GPA			20	55	1	-7	-16
	APT			-11	54	12	18	-5
	NSG			19	56	10	9	5
	GPA + APT			8	66	8	5	-14
	GPA + APT + NSG			12	65	9	6	-8
Comparison Composites								
	Overall Index	← 20 →			40	10	← 30 →	
	USNA selector composite[a]	25	35		40			

[a]Based on weights used for Naval Academy selection.

Given the current favorable selection ratio for NROTC (roughly 1 in every 8 or 10 of those passing the initial SAT pre-screen are selected), all of the experimental composites predict GPA well enough to be practically useful for NROTC selection. Figure 1 illustrates the practical impact for one of the experimental composites compared with the impact for the Overall Index and the Naval-Academy-based composite. Using the Overall Index and selecting the top 20 percent of applicants, for example, 58 percent of selectees would be expected to have GPAs above the 1979-1980 entering class median. Using the Naval-Academy-based selector composite, 63 percent would be above the median, and using one of the better experimental composites (e.g., the Set C composite designed to predict GPA + APT), 67 percent would be above the median.

OVERALL INDEX (R= .15)

Predictor Quintile	% Above Median	Percentage of Grade Point Averages: Below Median 75	60	45	30	15	MDN	Above Median 15	30	45	60	75
Top 20%	58					**********	[	**********				
Next 20%	54					**********	[	**********				
Middle 20%	50					**********	[	**********				
Next 20%	46					**********	[	**********				
Bottom 20%	42					**********	[	**********				

USNA SELECTOR COMPOSITE (R= .23)

Predictor Quintile	% Above Median	Percentage of Grade Point Averages: Below Median 75	60	45	30	15	MDN	Above Median 15	30	45	60	75
Top 20%	63					**********	[	**********				
Next 20%	56					**********	[	**********				
Middle 20%	50					**********	[	**********				
Next 20%	44					**********	[	**********				
Bottom 20%	37					**********	[	**********				

NEW COMPOSITE (SET C: GPA + APT) (R= .30)

Predictor Quintile	% Above Median	Percentage of Grade Point Averages: Below Median 75	60	45	30	15	MDN	Above Median 15	30	45	60	75
Top 20%	67					**********	[	**********				
Next 20%	57					**********	[	**********				
Middle 20%	50					**********	[	**********				
Next 20%	43					**********	[	**********				
Bottom 20%	33					**********	[	**********				

Figure 1. Comparison of several selector composites for predicting grade point average (percentage above median by predictor quintiles).

As illustrated in Figures 2 and 3 (see pp. 10-11), the expected level of APT and NSG could also be improved by using an experimental composite.

While changes in the applicant pool and less favorable selection ratios would be likely to reduce selector validities, the validities presented here have not been corrected for range restriction in the predictors and criteria and are likely lower than the true sample values.

CONCLUSIONS

Results of this research suggest that:

1. Reasonable and useful predictions of GPA, APT, and NSG can be achieved using SATV, SATM, and HSR as predictors.

2. These predictions are improved very little by adding INT, or the SCII or BQ as currently scored, to the predictor set.

3. Validities of the experimental composites are very similar whether those composites are designed to predict GPA, NSG, GPA + APT, or GPA + APT + NSG. Composites designed to predict APT are somewhat less valid except against the APT criterion.

4. There is considerable latitude in the effective weights that can be assigned to the various predictors while still maintaining good validity. For instance, composites that equally weight SATV and SATM have very comparable validities to those that optimally weight these two predictors.

5. All of the experimental composites have validities that are better than those of the present NROTC selector (the Overall Index), and most are also better than the selector generated using Naval Academy effective weights for SATV, SATM, and HSR. Improvement over the present index is especially great.

RECOMMENDATIONS

Based on these results, it is recommended that:

1. One of the more valid experimental composites be selected to replace the Overall Index in NROTC selection. (This recommendation has already been implemented with the February 1985 Selection Board's adoption of the Set D composite designed to predict NSG. The Appendix shows computing weights for this composite and provides a table for interpreting scores in relation to previous NROTC applicants.)

2. A program of continuing research aimed at further improving the selection system be established. Such a program has had excellent results at the Naval Academy and could probably also facilitate selection for NROTC.

OVERALL INDEX (R= .12)

Predictor Quintile	% Above Median	Percentage of Naval Aptitude Scores: Below Median 75	60	45	30	15	MDN	Above Median 15	30	45	60	75
Top 20%	56					**********	[	**********				
Next 20%	53					**********	[	**********				
Middle 20%	50				**********		[	**********				
Next 20%	47				**********		[	**********				
Bottom 20%	44				**********		[	**********				

USNA SELECTOR COMPOSITE (R= .04)

Predictor Quintile	% Above Median	Percentage of Naval Aptitude Scores: Below Median 75	60	45	30	15	MDN	Above Median 15	30	45	60	75
Top 20%	52					**********	[	**********				
Next 20%	51					**********	[	**********				
Middle 20%	50				**********		[	**********				
Next 20%	49				**********		[	**********				
Bottom 20%	48				**********		[	**********				

NEW COMPOSITE (SET C: GPA + APT) (R= .18)

Predictor Quintile	% Above Median	Percentage of Naval Aptitude Scores: Below Median 75	60	45	30	15	MDN	Above Median 15	30	45	60	75
Top 20%	60					**********	[	**********				
Next 20%	55					**********	[	**********				
Middle 20%	50				**********		[	**********				
Next 20%	45				**********		[	**********				
Bottom 20%	40				**********		[	**********				

Figure 2. Comparison of several selector composites for predicting naval aptitude (percentage above median by predictor quintiles).

OVERALL INDEX (R= .15)

Predictor Quintile	% Above Median	Percentage of Naval Science Grades: Below Median 75	60	45	30	15	MDN	Above Median 15	30	45	60	75
Top 20%	58					**********	[	**********				
Next 20%	54					**********	[	**********				
Middle 20%	50					**********	[	**********				
Next 20%	46					**********	[	**********				
Bottom 20%	42					**********	[	**********				

USNA SELECTOR COMPOSITE (R= .13)

Predictor Quintile	% Above Median	Percentage of Naval Science Grades: Below Median 75	60	45	30	15	MDN	Above Median 15	30	45	60	75
Top 20%	57					**********	[	**********				
Next 20%	53					**********	[	**********				
Middle 20%	50					**********	[	**********				
Next 20%	47					**********	[	**********				
Bottom 20%	43					**********	[	**********				

NEW COMPOSITE (SET C: GPA + APT) (R= .20)

Predictor Quintile	% Above Median	Percentage of Naval Science Grades: Below Median 75	60	45	30	15	MDN	Above Median 15	30	45	60	75
Top 20%	61					**********	[	**********				
Next 20%	55					**********	[	**********				
Middle 20%	50					**********	[	**********				
Next 20%	45					**********	[	**********				
Bottom 20%	39					**********	[	**********				

Figure 3. Comparison of several selector composites for predicting naval science grades (percentage above median by predictor quintiles).

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APPENDIX

OPERATIONAL AIDS

OPERATIONAL AIDS

Table A-1 gives computing weights for each of the predictors in the selector composite implemented in February 1985 (Set D). Computing weights are the "b" weights derived from multiple regression multiplied by 100. The multiplication factor was included so that the final composite scores would center around a mean of about 250 rather than 2.5 and would not be confused with predicted GPAs. Table A-2 (see p. A-2) shows how to interpret scores on the composite.

Table A-1

Computing Weights for the NROTC
Selector Composite

Predictor	Computing Weight
SATV	.0542619
SATM	.0542619
HSR	.9481170
INT	5.0940000
SCII	.4991990
BQ	.4270220

In Table A-2, deciles are based on individuals applying to enter NROTC in 1982 who had taken all six of the predictor tests. In using the table, an applicant with a composite score of 275, for example, would rank in the top 10 percent compared with previous applicants. Barring unfavorable evaluations by teachers or other contraindications of success, such an individual would be among the better prospects for selection. Conversely, individuals in the lower deciles would compare unfavorably with previous applicants and would have poorer chances of success.

Table A-2

Decile Conversions for the NROTC Selector Composite

Selector Composite Score	Decile in Which That Score Falls Relative to Previous Applicants	
273 and above	10	(Top 10%)
262 - 272	9	
255 - 261	8	
249 - 254	7	
243 - 248	6	
237 - 242	5	
231 - 236	4	
224 - 230	3	
214 - 223	2	
213 and below	1	(Bottom 10%)